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Influence of Potassium Fertilization on Barhee Date Palms Growth, Yield and Fruit Quality Under Heat Stress Conditions.

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ABSTRACT

This study aimed to evaluate the effects of many potassium fertilization methods on growth, productivity and fruit quality of date palm trees c.v Barhee grown under heat stress in Tushka region, Aswan Governorate, Egypt. Applied potassium fertilization (as K_2SO_4 (48% K_2O)) to date palm trees by four methods i.e., control treatment (without potassium), Soil application at (1, 2 and 3 kg/palm, Foliar application at (1, 2 and 3% K_2SO_4) and Injection into the trunk at (1, 2 and 3% K_2SO_4). Results showed that the highest vegetative growth, yield and fruit quality were found from trunk injection method at 3% as comparative with control, also compared to other treatments in two studied seasons. On the hand, this study showed that leaf mineral contents especially potassium increased significantly comparing to control. In additions, Potassium injection method was surpassed than the other methods and that may be due to the direct transfer the element to the specific parts of the plant through trunk, applying injection methodcould help us to solving the problem of absorption and transmission of potassium in date palm trees.

Keywords: Tushka conditions, Barhee, date palm, Potassium, soil addition, foliar application, trunk Injection, vegetative growth, yield and fruit quality.

INTRODUCTION

Date palm trees (*Phoenix dactylifera*) are the most common fruit tree grown in arid and semiarid of the Middle East and North Africa regions. In Egypt, the number of fruitful female palms is about fifteen million (14,956,331) planted in approximately 115610 feddan produced (1684917) metric tons of fresh, semi-dry and dry dates according to statistical (Ministry of Agriculture in 2016).

The orchard management successful practices are directed toward obtaining balance productivity with high fruit quality. In the date palm trees orchards fertilization is one of the most important cultural practices. Fruit quality and quantity can increase by fertilization and gave a high date palm yield. All fruit physical and chemical properties were affected when any shortage occurs of any elements; many previous studies recorded that (Melouk, *et al*., 1999; and Shawky, *et al*., 1999). (Dong, *et al*., 2005) Recently, the main question of every researcher or grower has been how to minimizing mineral fertilizers? It is become the main goals of many researchers because leaching loss or votalization etc., and maximizing nutrient uptake by crops, increasing public concern, excessive nutrient loss from agricultural land encourages the researchers to find more efficient ways to apply fertilizers.

Trunk injection one of the efficient new methods of fertilizers application in fruit tree nutrition. Also, the nutrient requirements of trees, particularly date palms, vary greatly from one stage of growth to another of tree life.while, the old fashion methods of plant nutrition depended on soil additions methods (broadcasting, splitting, dressing and fertigation), then fertilization method by foliar application can be only serving as supplementing particular cases (When we need to compensate for the lack of some elements,high pH values of the solution soil, high CaCO3 content, high salinity, etc.). A small portion of soil-added fertilizers is taken up by root of plants, especially with those grown under sandy soil conditions (many previous studies proved that), where high permeability allows obtained fast leaching of fertilizers to underground water (Halliday and Trenkel 1992). (Mahmud, 2009) demonstrated that trunk injection fertilization: a full nutritional technique for fruit trees saves 90-95% of fertilizers and maintains a clean environment. (Abdi, and Hedayat, 2010) they mentioned that, potassium fertilization were enhanced productivity and fruit quality in palm trees c.v 'Kabkab' compared to control and other application methods of potassium , trunk injection method was more efficient than different other methods. Using this method may help us to solve the problem of absorption and transfer of potassium in fruit trees, especially date palms because this method is important in the delivery of potassium to vital and influential places in the plant. (Jahanshah, *et al.,* 2016) recorded that tree treated by trunk injection is a better method for iron fertilization of date palms grown in calcareous soils. Injection Fe at 200 mg/l to trunk increased significant TSS, fruit set %, fruit weight, flesh weight, fruit size, total, reducing and non-reducing sugars of date palm cv. Kabkab.

Potassium play a major role of water loss which resulted from increasing evapotranspiration caused by high temperature because the potassium plays role in water relations in fruit trees, enzyme reactions and protein synthesis . Meanwhile, the tree leaves water status is very critical. Potassium play a role in the carbohydrates produce in the leaves and this is necessary for the growth roots, uptake nutrients, shoot growth, leaves and fruits. Potassium also plays an important role in protecting trees from the risk of winter frost which, in spring protects the buds and flowers. Therefore, potassium is considered an important element of the date palm. growth and productivity (Al-Kharusi *et al.,* 2009). Also, potassium plays a key role in N uptake and translocation from roots to vegetative growth (Cushnahan *et al*., 1995). Generally, potassium plays an important role in controlling cell water content and carbohydrates biosynthesis and mobilization in plant tissues, consequently carbohydrates play a serious role in vegetative growth, fruit set, yield and fruit

quality (Harhash and Abdel-Nasser, 2007; Khayyat *et al*., 2007; Shahin, 2007; Harhash and Abdel-Nasser 2010). Potassium is necessary for basic physiological functions, such as the formation of sugars and starch, the synthesis of proteins, cell division and growth fruit formation and could improve fruit size, flavor and color (Abbas & Fares, 2008, Holzmueller *et al.,* 2007).

Zagzog & Salem, 2016) investigated the effect of potassium sulfate and boron on yield and fruit quality of Hayany date palm c.v and showed that potassium sulfate with 2 kg/palm as soil application and 60 mg /l boron as foliar application was increased the yield , bunch weight and enhance fruit physical and chemical properties compared to control. Potassium fertilization addition in May and December with two equal doses or in March , May and December with three equal doses was better, which 600 g K2O/palm/season as the economic rate of potassium fertilization for date palms on sandy soil (Salama, 2007 & Abdel-Nasser and El-Shazly 2001).Furthermore, (Osman, 2010) mentioned that The yield and the quality of the fruits were increased when the date palm trees were treated with potassium sulfate with 4 kg / palm / season.Potassium sulfate also increased the weight of the bunches and improved the minerals content of leave palm trees. The aim of this study evaluates the methods of potassium application (soil addition, foliar application and trunk injection) to date palms Barhee c.v and studies its effects on growth, yield and fruit quality under heat stress in tushka region.

MATERIALS AND METHODS

This study was conducted out during 2016 and 2017 seasons at Agricultural Research Center farm in Toshka – Aswan - Egypt in order to study the effect of potassium fertilization methods on growth, yield and fruit quality of Barhee date palm cultivar. Four methods of potassium fertilization i.e. – control - soil addition K_2SO_4 at 1, 2 and 3kg/tree/year - bunch foliar application K_2SO_4 at 1, 2 and 3% - trunk injection by K_2SO_4 at 1, 2 and 3%. In this study, thirty healthy palms similar in growth vigor were selected. The palm trees were planted at 7 x 7 meters apart and received the normal cultural practices commonly adopted for this area except the tested fertilization treatments. The palm trees were grown in sand soil under drip irrigated system. Mechanical and chemical analyses of farm soil were done as shown in Table 1 (a&b).

Table 1a. Soil particles distribution and texture of the experiment soil at Toshka

Depths (cm)	Coarse sand%	Fine sand%	Silt%	Clay%	Texture
0-30	70.91	20.95	5.95	0.79	Sand
30-60	70.23	22.27	6.71	0.81	Sand

Table 1b. Some soil physio-chemical properties of the experiment soil at Toshka

soil depth {cm}	Field Capacity (FC) %	Available Water (AvW) %	Wilting Point (WP) %	pH	Organic Matter (OM) %	Nitrogen (N) %	Phosphorus (P) ppm	Potassium (K) ppm
0-30	16.71	6.33	10.4	8.14	0.26	0.21	2.5	22.3
30-60	16.5	6.11	10.4	8.03	0.2	0.23	2.38	22.3

Ten treatments application was arranged in a completely randomized design with three replicates (1replicate = 1 palms) per treatment (i.e. 10×3 = 30 palms).

The treatments were as follows:

T1; Control.
T2; Soil application of 1 kg/palm as potassium sulfate/year.
T3; Soil application of 2 kg/palm as potassium sulfate/year.
T4; Soil application of 3 kg/palm as potassium sulfate/year.
T5; Foliar spray of potassium sulfate (1%).
T6; Foliar spray of potassium sulfate (2%).
T7; Foliar spray of potassium sulfate (3%).
T8; potassium sulfate injection into the trunk of tree (1%).
T9; potassium sulfate injection into the trunk of tree (2%).
T10; potassium sulfate injection into the trunk of tree (3%).

The total of potassium amount and concentration of each treatments divided into four equal batches and applied at the first March, April (after fruit set) May (during fruit maturity) and June. Spraying treatments was maintained just to cover the bunch completely till drip. For trunk injection each tree drilled with a hand drill 1.5 m in height and 30 cm depth with 45 hermitages to down. At harvesting time, leaf length was measured and recorded number of leaflet per leaf was accounted and recorded, leaflet length and width, total chlorophyll was measured (using a chlorophyll meter SPAD 502). The air temperatures and relative humidity in study region during 2015 and 2016 years were as in table (2).

Fruit Set Percentage: Abnormal and normal fruit set for ten strands per spath were recorded. Fruit setting percentage was calculated by using the following formula:

$$\text{Fruit set\%} = \frac{\text{Total number of normal fruit set - Number of abnormal fruit set}}{\text{Total number of fruits}} \times 100$$

Yield (kg/tree) and bunch weight: at harvest time average bunch weight were recorded and palm yield were calculated.

Twenty fruits were randomly picked to estimate physical and chemical characteristics:-

Fruit physical characteristics: At baser stage a fruit samples were randomly collected from each replicate in both seasons for each treatment and transported immediately to the laboratory to determine the fruit physical characteristics i.e. fruit weight, length, diameter, shape index (L/D), flesh weight, seed weight (gm), and finally seed/fruit ratio were determined according to (A.O.A.C., 2005).

Fruit chemical characteristics: Chemical properties of fruits at baser stage namely total soluble solids (TSS) was measured by a hand refractometer, acidity (%) was determined by titration according to (A.O.A.C., 2005), Tss/acid ratio was calculated. sugar content (total sugar, reducing and non-reducing) were determined according to Miller, G.L. (1959).

Leaf mineral contents: At the end of each growing season, leaflet samples were collected, washed and dried at 70°C until constant weight and then grounded for determination the following nutrient elements (as dry weight): (N, P, K, Ca and Mg) according to Wilde *et al.,* (1985).

Statistical Analysis: The obtained data of both seasons were subjected to analysis of variance according to **Snedecor and Cochran, (1989)** and the means were differentiated using Duncan multiple range test at 5% level. Duncan, (1955).

Table 2. Air temperatures and relative humidity in study region during 2015 and 2016 years

Month	2015						2016					
	Air temperature			relative humidity			Air temperature			relative humidity		
	Maxi-	Mini-	Aver-	Maxi-	Mini-	Aver-	Maxi-	Mini-	Aver-	Maxi-	Mini-	Aver-
January	23.84	9.15	16.50	55.5	21.8	38.7	22.32	9.89	16.10	53.97	22.58	38.28
February	27.94	12.06	20.00	45.79	12.68	29.24	27.68	12.33	20.00	45.56	13.34	29.45
March	32.41	15.80	24.10	33.71	4.82	19.26	33.45	16.63	25.04	41.02	7.67	24.35
April	33.3	16.1	23.9	25.0	4.2	14.6	38.08	19.25	28.67	25.94	3.53	14.73
May	38.82	22.73	30.77	26.09	4.20	15.15	40.86	23.53	32.19	22.75	3.27	13.01
June	40.36	25.18	32.77	32.19	5.73	18.96	43.47	25.85	34.66	21.92	3.17	12.55
July	41.24	24.08	32.66	28.35	4.78	16.56	41.97	26.49	34.23	26.03	5.18	15.60
August	44.03	29.14	36.59	28.36	5.72	17.04	41.92	26.44	34.18	27.86	4.98	16.42
September	42.29	26.68	34.49	28.93	4.91	16.92	40.07	24.64	32.35	31.78	7.03	19.41
October	38.38	23.87	31.13	40.97	10.68	25.82	37.46	21.77	29.61	37.62	11.57	24.60
November	29.86	15.58	22.72	54.68	22.34	38.51	32.14	17.83	24.99	47.97	19.00	33.48
December	23.11	9.94	16.52	61.09	25.93	43.51	31.15	16.58	23.87	48.97	20.12	34.55

RESULTS AND DISCUSSION

Vegetative growth parameters:

Leaf length (m):

Significant effect was found with potassium fertilization in both seasons Table (3). Trunk injection at 3% k2so4/palm/year as shown in table(2) the greatest leaf length was (4.53 and 4.56m) followed by trunk injection with 2% /palm/year (4.51and 4.53m)in the first and second seasons ,respectively as compared with control and the other treatments.

Number of leaflet/leaf:

As shown in Table (3) there was significant increase on number of leaflet/leaf was showed of Barhee date palm cultivar due to the potassium fertilization in the two seasons. Potassium trunk injection at 3%/palm/year led to the higher number of leaflet/leaf (194.33 and 195.67) followed by potassium trunk injection at 2% treatment (194.33 and 194) compared to the control and other treatments in the first and second seasons, respectively.

Leaflet length and width (cm):

From data in Table (3) leaflet length and width was significantly affected by potassium fertilization in both seasons. Potassium trunk injection at 3%/palm had the greater leaflet length (56.59 and 56.89cm) and width (4.21 and 4.21cm) as compared with control and other treatments in two seasons, respectively.

Total chlorophyll content:

Data in Table (3) revealed significant effect on total chlorophyll content of Barhee date palm c.v due to the potassium fertilization in the two seasons. Potassium trunk injection at 3%/palm recorded the highest significant total chlorophyll content (56.96 and 56.60) followed by potassium trunk injection at 2%/palm (54.71 and 56.23) comparing with the control and other treatments in the first and second seasons, respectively.

Finally, the results also, indicated that the difference between the potassium fertilization methods tends to increase the vegetative growth of palm trees. Potassium foliar application as K2SO4 showed the lowest vegetative growth than soil surface addition and injection method except control treatment. Finally, K injection to the trunk of the tree was more effective than the other K fertilization methods. K injection increased average vegetative growth. The highest rate of K fertilization methods surpassed low rates and gave the best values with vegetative growth in both seasons.

This increment in Barhee date palm vegetative growth by potassium fertilization treatments may be attributed due to the potassium plays a vital role in controlling cell water content , carbohydrates biosynthesis and mobilization in plant tissues, consequently carbohydrates play an important role in vegetative growth (Harhash and Abdel-Nasser, 2007; Khayyat *et al.,* 2007; Shahin, 2007; Harhash and Abdel-Nasser 2010).These results are in agreement with those obtained previously by (EL-Hammady et al, 1991 and Montasser *et al*. 1991) they mentioned that use 2 or 3 Kg of potassium sulphate to enhancement and increase the vegetative growth of some date palm cultivar.

Fruit set (%):

Results in table (4) indicated that potassium fertilization had significant effect on fruit set (%) in both seasons. Potassium trunk injection treatment at 3%gave the highest fruit set percentage (75.93 and 76.11%) followed by potassium trunk injection at 1 %(74.52 and 74.03%) compared to the control (untreated palms) and other treatments for Barhee date palm cultivar in both studied seasons, respectively.

Yield/palm (kg:)

Concerning the data of yield per palm (kg) in the same table (4), the obtained result indicated that there were significant differences among treatments in the

two seasons. Potassium trunk injection at 3% gave the highest yield /palm (93.21 and 93.35kg) followed by potassium trunk injection at 2% (90.73 and 93.34kg) compared to the control and other treatments in the first and second seasons, respectively.

Table 3. Effect of potassium fertilization on Barhee date palms of vegetative growth during 2016&2017 seasons.

Treatments	Leave length (cm)		No. of leaflet Per leaf		Leaflet length (cm)		Leaflet width(cm)		Total chlorophyll	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	4.05f	3.97g	151.67h	151.33e	44.55g	45.02f	3.22f	3.16e	41.75f	42.97d
K-soil addition:-										
1kg/tree/year	4.30d	4.31e	176.67g	181.00c	49.94f	50.52de	3.77e	3.79c	48.90cd	51.35c
2kg/tree/year	4.46d	4.37de	186.33bc	183.33c	52.20c	51.28cd	3.89e	3.97c	50.89c	53.27b
3kg/tree/year	4.47c	4.48cd	187.00b	188.67b	52.48c	54.30bc	3.98c	4.00c	53.83b	54.12b
K-foliar application:-										
spray at 1%	4.17e	4.19f	174.00f	177.00d	49.44e	50.44e	3.77e	3.82d	46.61e	50.10c
spray at 2%	4.37e	4.21f	177.67e	179.33d	50.08d	51.47de	3.78e	3.85d	46.36e	50.31c
spray at 3%	4.38e	4.40f	179.33d	180.33d	50.56d	52.01de	3.79e	3.87d	48.24de	51.24c
K-trunk injection:-										
Injection at 1%	4.44b	4.50c	188.33ab	191.33a	52.55c	55.11ab	3.93c	4.08b	53.51b	55.57a
Injection at 2%	4.51a	4.53b	194.33a	194.00a	55.00b	55.00a	4.01a	4.08a	54.71ab	56.23a
Injection at 3%	4.53a	4.56a	194.33a	195.67a	56.59a	56.89a	4.21a	4.21a	56.96a	56.60a

Means with the same letter are not significantly different.

The increment in yield may be attributed to the increase in length of growing leaves. Consequently, an increase will be expected in the photosynthesis rate. In addition, this increment in Barhee date palm yield by K treatments may be attributed to the physiological role of potassium in enhancing many metabolic processes such as carbohydrate formation, translocation and accumulation. Archer (1985) showed that photosynthesis translocation depended on cell potassium concentration. The increasing yield per palm may be due to the trunk injection by K conveys the element directly to the respective parts of plant, may be using trunk injection methods could help us to solve the problem of absorption and transmission of potassium in date palm. Presence of sufficient amounts of available K causes an increase in metabolism in plant. Also, K plays a crucial role in processes in plants that require electron transfer reactions, including photosynthesis and nitrogen assimilation (activation of nitrate reeducates).The obtained results are in close agreement with those found by (Osman, 2010; Shahin, (2007; Bamiftah, 2000; Abdel-Nasser and El-Shazly, 2001;Harhash, 2000.;Shawky *et al.,* 1999; EI-Hammady *et al*., 1991 and Al-Kharusi *et al*., (2007) who studied the effect of potassium fertilization on yield, and found that the K applied at three doses in March, June and September gave the highest palm yield.

Bunch weight (kg):

As shown in Table (4) bunch weight (kg) was significantly affected by potassium fertilization in the two seasons. Potassium trunk injection at 3% resulted in the greatest bunch weight (11.63 and 11.68kg)followed by potassium trunk injection at 2% (10.68 and 11.43kg) and potassium trunk injection at 1% (10.30 and 11.29kg) as compared with the control and the other treatments in the first and second seasons, respectively. The present results are in agreement with those obtained previously by Zagzog and Salem, 2016.

Table 4. Effect of potassium fertilization on Barhee date palms of fruit set, yield, bunch weight and fruit weight during 2016&2017 seasons.

Treatments	fruit set (%)		Yield /palm (kg)		Bunch weight(kg)	
	2016	2017	2016	2017	2016	2017
Control	53.88h	51.95g	68.05h	70.90g	7.80f	7.96e
K-soil addition:-						
1kg/tree/year	68.71g	66.83d	77.03f	81.85cd	9.32e	9.63c
2kg/tree/year	71.09e	68.23cd	80.95e	82.34cd	9.90cd	10.25b
3kg/tree/year	73.68d	68.92c	82.65d	83.75c	9.96c	10.24b
K-foliar application:-						
spray at 1%	69.84f	61.07f	79.35g	79.61f	9.15e	8.87d
spray at 2%	70.75ef	62.63e	79.69f	80.09ef	9.43e	9.28cd
spray at 3%	71.25e	62.09ef	81.25e	81.23de	9.46de	9.12d
K-trunk injection:-						
Injection at 1%	74.52c	74.03b	89.19b	89.92b	10.30bc	11.29a
Injection at 2%	75.62ab	75.36ab	90.73b	93.34a	10.68b	11.45a
Injection at 3%	75.93a	76.11a	93.21a	93.35a	11.63a	11.68a

Means with the same letter are not significantly different.

Fruit physical characteristics:

Fruit weight (g):

Data presented in Table (5) revealed that significant effect was found in fruit weight (g) of Barhee date palm cultivar due to the potassium fertilization in both seasons. Potassium trunk injection at 3%gave the highest fruit weight (18.81 and 18.92g) followed by potassium trunk injection at 2% (18.69 and

18.74g followed by potassium trunk injection at 1% (18.65 and 18.55g) compared to the control (untreated palms) and other treatments in the 2016 and 2017 seasons, respectively.

Fruit dimensions (cm):

Fruit length (c):

It is obvious from Tale (5) that fruit length was significantly increased by potassium treatments in the two studied seasons. Potassium trunk injection at 3% gave the highest fruit length (3.50 and 3.70cm) followed by potassium trunk injection at 2% (3.43 and 3.60cm) as compared with control and other treatments during 2016 and 2017, respectively.

Fruit width (cm):

Table (5) indicated that fruit width was significantly increased by potassium treatments in the two seasons. Potassium trunk injection at 3% gave the highest fruit width (2.87 and 2.90cm) followed by potassium trunk injection at 2% (2.83 and 2.80cm) as compared to control and other treatments in the first and second seasons, respectively.

Flesh weight (g):

Significant effect was found on flesh weight of Barhee date palm cultivar due to the potassium treatments in both seasons. Potassium trunk injection at 3% gave the highest flesh weight (16.91 and 16.93g) followed by potassium trunk injection at 2% (16.22 and 16.33g) and potassium trunk injection at 1% (16.17 and 16.58g)compared to the control and other treatments in two studied seasons, respectively Table (5).

Seed weight (g):

As shown in Table (5) seed weight was significantly decreased by potassium treatments in the two seasons. Untreated palms(control) gave the highest seed weight (2.92 and 2.78g) which, potassium trunk injection at 1 , 2 and 3% gave the lowest seed weight compared to control and the other treatments in the first and second seasons, respectively.

regarding, fruit physical characteristics increments may be attributed to that potassium plays an important role in controlling cell water content and carbohydrates biosynthesis and mobilization in plant tissues, consequently carbohydrates play a serious role in vegetative growth, fruit set, yield and fruit quality (Harhash and Abdel-Nasser, 2007; Khayyat *et al.,* 2007; Shahin, 2007; Harhash and Abdel-Nasser, 2010).These results are in agreement with those obtained by (EI-Hammady *et al*., 1991; Bamiftah, 2000; Abdi and Hedayat, 2010; Osman, 2010 and Jahanshah *et al.,* 2016) who studied the effect of potassium fertilization on yield, fruit quality of date palm, and found that potassium applied gave the highest fruit and flesh weight and length.

Table 5. Effect of potassium fertilization on Barhee date palms fruit physical properties during 2016&2017 seasons.

Treatments	Fruit weight (g)		Fruit dimensions				Flesh weight (g)		Seed weight (g)	
			Fruit length (cm)		Fruit width (cm)					
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	14.87e	15.08e	3.03e	3.17f	2.17f	2.20f	11.95e	12.30e	2.92a	2.78a
K-soil addition:-										
1kg/tree/year	17.86cd	17.68c	3.30c	3.43cd	2.57d	2.57d	16.69d	16.52c	1.17c	1.16cd
2kg/tree/year	17.92cd	17.94c	3.30c	3.43cd	2.60cd	2.63cd	16.79d	16.65c	1.13c	1.29c
3kg/tree/year	18.30bc	18.23b	3.40b	3.53bc	2.70bc	2.73bc	16.98cd	16.95c	1.32bc	1.28c
K-foliar application:-										
spray at 1%	17.60d	16.92d	3.23c	3.30e	2.43e	2.40e	16.23c	15.91d	1.37bc	1.01de
spray at 2%	17.72cd	16.95d	3.13d	3.30e	2.50de	2.40e	16.31c	15.96d	1.41b	0.99e
spray at 3%	17.82cd	17.76c	3.27c	3.37de	2.53de	2.53d	16.38c	16.15d	1.44b	1.61b
K-trunk injection:-										
Injection at 1%	18.65ab	18.55a	3.40b	3.57b	2.77ab	2.77b	17.67ab	17.65b	0.98cd	1.00de
Injection at 2%	18.69ab	18.74a	3.43ab	3.60ab	2.83a	2.80ab	17.72ab	17.73ab	0.97cd	1.01de
Injection at 3%	18.81a	18.92a	3.50a	3.70a	2.87a	2.90a	17.89a	17.93a	0.92d	0.99f

Means with the same letter are not significantly different.

Fruit Chemical characteristics:-

Total soluble solids percentage:

Data presented in Table (6) show the total soluble solids, total acidity, total sugars, reducing sugars and non-reducing sugars of Barhee date palm cultivar in the two seasons. Potassium trunk injection at 3% achieved the highest total soluble solids (34.65 and 35.69%) followed by potassium trunk injection at 2% (33.75 and 34.25%) compared to those of untreated palms (control) and other treatments in the first and second seasons, respectively.

Total acidity:

Total acidity percentage Table (6) was significantly decreased by potassium treatments in the two seasons, potassium trunk injection at 3% showed the lowest total acidity percentage (0.22 and 0.20%) in the first and second season, respectively and followed by potassium trunk injection at 2%gave the lowest acidity percentage in the second seasons only compared with the control and other treatments.

Tss/acid ratio:

As shown in Table (6) tss/acid ratio was significantly affected by potassium treatments during 2016 and 2017 seasons. Potassium trunk injection at 3% surpassed other treatments and control (175.04 and 178.45), respectively in two studied seasons.

Total Sugars %:

Table (6) revealed that significant effect was found in total sugars percentage of Barhee date palm cultivar due to the potassium fertilization in both seasons. Potassium trunk injection at 3%treatment resulted in the greatest total sugars percentage (32.16

and 32.46%) followed by potassium trunk injection at 2% (31.33 and 31.87%) in the first and second seasons, respectively as compared with control and other treatments.

Reducing sugars %:

Significant effect was found in reducing sugars percentage of Barhee date palm due to the potassium fertilization in the two seasons, Table (6). Potassium trunk injection at 3% exhibited the highest reducing sugars percentage (22.77 and 22.83%), followed by potassium trunk injection at 2% (22.22 and 22.64%) compared to the control and other treatments in the first and second seasons, respectively.

Table 6. Effect of potassium fertilization on Barhee date palms fruit chemical properties during 2016&2017 seasons.

Treatments	TSS (%)		Acidity (%)		TSS/Acid Ratio		Total sugars (%)		Reducing sugars (%)		Non reducing sugars	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	27.80f	28.40g	0.32a	0.35a	86.98g	81.93f	25.76h	25.93i	20.15gh	19.51h	5.61e	6.31d
K-soil addition:-												
1kg/tree/year	32.23cd	32.93d	0.25bc	0.23c	129.12d	143.14d	29.53de	30.04e	20.85ef	20.74eg	8.68cd	9.27ab
2kg/tree/year	32.05a	33.50c	0.25bc	0.22d	127.92de	152.27c	29.56d	30.64d	21.06de	21.24de	8.50cd	9.40a
3kg/tree/year	33.54b	33.85bc	0.24cd	0.21de	139.75c	158.75b	30.70c	30.80d	21.38cd	21.78cd	9.32a	9.02b
K-foliar application:-												
spray at 1%	30.60e	30.69f	0.26b	0.24bc	119.30f	129.70e	28.28g	28.04h	20.07h	20.48g	8.21d	7.52c
spray at 2%	30.69e	30.97f	0.25bc	0.24b	121.20f	129.02e	28.62fg	28.49g	20.39fgh	20.65fg	8.23d	7.84c
spray at 3%	31.11de	31.85e	0.25bc	0.23c	122.85ef	138.47d	28.91ef	28.93f	20.62efg	21.14ef	8.29d	7.79c
K-trunk injection:-												
Injection at %	32.97bc	34.19b	0.23de	0.21e	141.65c	163.03b	30.27c	31.24c	21.80bc	22.18bc	8.47cd	9.06b
Injection at 2%	33.75ab	34.25a	0.23ef	0.20f	148.96b	171.25a	31.33b	31.87b	22.22b	22.64ab	9.11b	9.23ab
Injection at 3%	34.65a	35.69a	0.22f	0.20f	175.04a	178.45a	32.16a	32.46a	22.77a	22.83a	9.39a	9.63a

Means with the same letter are not significantly different.

Non-reducing sugars%:

Non-reducing sugars percentage Table (6) was significantly affected by potassium fertilization in the two seasons 2016 and 2017. Potassium trunk injection at 3% gave the greatest non-reducing sugars percentage (9.39 and 9.63%) as compared with control and other treatments in the first and second seasons, respectively.

The obtained results are due to the fact that potassium is necessary for basic physiological functions, such as the formation of sugars and starch, the synthesis of proteins, cell division and growth fruit formation and could improve fruit size, flavor and color (Abbas and Fares, 2008; Holzmueller *et al.,* 2007 and Zagzog and Salem, 2016).The obtained results appeared to be in close agreement with the findings reported by (EI-Hammady *et al*. 1991; Soliman and Osman, 2003; Osman, 2009 and Osman, 2010) who found that chemical fertilizers (NPK) improved chemical properties (TSS%, total, reducing and non-reducing sugars percentage).

Leaf mineral contents:

Leaf nitrogen:

Data in Table (7) revealed that significant effect was found in leaf nitrogen percentage of Barhee date palm cultivar due to the potassium fertilization in both seasons. Treated date palms with potassium trunk injection at 3% resulted in the greatest leaf nitrogen percentage (1.93 and 1.95%), followed by potassium trunk injection at 2% (1.90 and 1.92%), respectively as compared with control (untreated palms) and the other treatments in two studied seasons.

Leaf phosphorus (%):

Leaf phosphorus percentage Table (7) was significantly affected by potassium fertilization in both studied seasons. Results indicated that potassium trunk injection treatments (3%) surpassed and gave the highest values of leaf phosphorus percentage (0.46 and 0.46), respectively compared to control and the other treatments in both studied seasons.

Leaf potassium (%):

As shown in Table (7) was significantly affected by potassium fertilization in both studied seasons. Data showed that, potassium trunk injection at 3% resulted in the greatest leaf potassium percentage (1.78 and 1.79%) as compared with control and other treatments in the first and second seasons, respectively.

Leaf calcium (%):

Significant effect was found in leaf calcium percentage of Barhee date palm cultivar by the potassium fertilization in the two seasons, Table (7). Potassium trunk injection at 3%was gave the highest leaf calcium percentage (2.44 and 2.45%) in the first and second seasons,respectively,followed by potassium trunk injection at 1% (2.41%)in the second season only.

Leaf magnesium (%):

Table (7) revaluated that tree treated with K-trunk injection at 3% K_2So_4 treatment gave similar and higher positive effect on leaf magnesium content as compared with the control and other treatments(0.45 and 0.46) in both seasons, respectively.

Finally, increasing leaf mineral contents because the potassium fertilization may be attributed to improve plant ability to uptake soil nutrients by increasing potassium fertilization. Also, enhancement plant uptake reflects on increasing vegetative growth and consequently improves efficiency for absorption and utilization of nutrients (Mangle and Kirkby, 1987and Abdel-Nasser and El-Shazly, 2001). These results are in harmony with those obtained by (Soliman and Osman, 2003; Shahin 2007; Osman, 2009 and Osman, 2010) who found that the leaf N, P and K content was increased, while Zn decreased with increasing the N and K fertilization rates.

Table 7. Effect of potassium fertilization on Barhee date palms leaf mineral contents during 2016&2017 seasons.

Treatments	N (%)		P (%)		K (%)		Ca (%)		Mg (%)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Control	1.29g	1.34h	0.25d	0.23	1.40g	1.42bc	1.72e	1.75e	0.27f	0.26e
K-soil addition:-										
1kg/tree/year	1.67ef	1.89de	0.34c	0.41b	1.64d	1.74a	1.86c	2.04cd	0.41cd	0.40d
2kg/tree/year	1.74cd	1.90cd	0.35bc	0.42b	1.65d	1.76a	1.91c	2.16c	0.42bc	0.41cd
3kg/tree/year	1.78bc	1.91bc	0.37b	0.42b	1.68c	1.76a	1.96c	2.30b	0.43bc	0.43c
K-foliar application:-										
spray at 1%	1.62f	1.85fg	0.36bc	0.39b	1.53ef	1.69ab	1.89c	2.00d	0.39e	0.40d
spray at 2%	1.69de	1.84g	0.34c	0.40b	1.55f	1.37c	1.83ce	2.12cd	0.40cd	0.40d
spray at 3%	1.69de	1.87ef	0.34c	0.40b	1.56e	1.71ab	1.74de	2.13c	0.40cd	0.41cd
K-trunk injection:-										
Injection at 1%	1.81b	1.91bc	0.44a	0.42b	1.74b	1.78a	2.21b	2.41ab	0.43b	0.45b
Injection at 2%	1.90a	1.92b	0.45a	0.44a	1.76ab	1.78a	2.33a	2.40a	0.45a	0.46a
Injection at 3%	1.93a	1.95a	0.46a	0.46a	1.78a	1.79a	2.44a	2.45a	0.45a	0.46a

Means with the same letter are not significantly different.

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تأثير التسميد البوتاسى على النمو والمحصول وصفات جودة ثمار النخيل البارحى تحت ظروف الإجهاد الحرارى

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تهدف هذه الدراسة إلى تقييم تأثير طرق التسميد المختلفة بالبوتاسيوم على نمو والمحصول وجودة ثمار نخيل ابلح البرحي تحت ظروف الإجهاد الحرارى بمنطقة توشكى بمحافظة أسوان ، مصر. التسميد البوتاسى بكبريتات البوتاسيوم (48% اكسيد بوتاسيوم) تم بثلاث طرق غير الكنترول: كنترول (بدون تسميد بوتاسى) - إضافة أرضية لكبريتات البوتاسيوم بمعدل 1،2و3كجم لكل نخلة كل سنه - رش ورقى بكبريتات البوتاسيوم بمعدل 1،2 و3% - حقن الجزع بكبريتات البوتاسيوم بمعدل 1، 2 و 3%. أظهرت النتائج ان أعلى قيم للنمو الخضرى والمحصول وجودة الثمار كانت عندما تم حقن جزع النخلة بكبريتات البوتاسيوم بمعدل3% وذلك مقارنة بالكنترول والمعاملات الأخرى فى كلا موسمى الدراسة . من ناحية أخرى ،أظهرت النتائج أن محتوى الأوراق من العناصر وخاصة البوتاسيوم زادت معنويا وقد أظهر البحث أن طريقة حقن الجزع كانت أفضل الطرقعن الطرق الأخرى المستخدمة وذلك بسبب أن طريقة حقن الجزع تنقل العنصر مباشرة إلى أجزاء النبات المعنية من خلال الجذع، وبذلك يكون استخدام هذه الطريقة (حقن الجزع) يمكن ان تساعد فى إمتصاص ونقل البوتاسيوم فى نخيل البلح بطريقة أفضل وأوفر من طرق الإضافة الأخرىالمدروسة بالبحث.